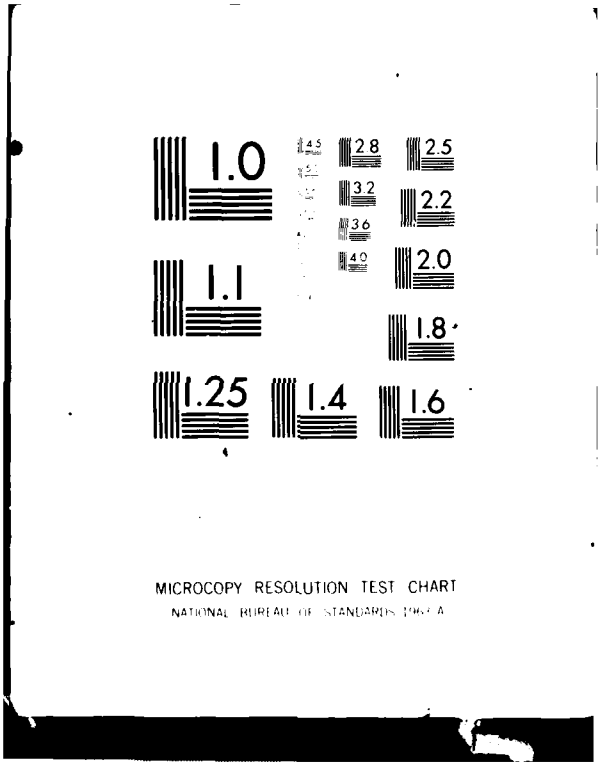
AD-A096 796 AIR FORCE ENVIRONMENTAL TECHNICAL APPLICATIONS CENTER--ETC F/G 4/2
BIVARIATE NORMAL WIND STATISTICS MODEL: USER'S MANUAL.(U)
SEP 80 B NOVOGRAD
UNCLASSIFIED USAFETAC/TN-80/003 SBIE-AD-E850 021 NL


1.0
1.1
1.25
1.4
1.6
1.8
2.0
2.2
2.5
2.8
3.2
3.6
4.0
4.5
MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS 1963-A

LEVEL III

USAFETAC/TN-80/003

BIVARIATE NORMAL WIND STATISTICS MODEL User's Manual

Benjamin Novograd, 2Lt, USAF

September 1980

UNITED STATES AIR FORCE
AIR WEATHER SERVICE (MAC)

USAF ENVIRONMENTAL
TECHNICAL APPLICATIONS CENTER
SCOTT AIR FORCE BASE, ILLINOIS 62225

REVIEW AND APPROVAL STATEMENT

USAFETAC/TN-80/003, Bivariate Normal Wind Statistics Model: User's Manual, September 1980, is approved for public release. There is no objection to unlimited distribution of this document to the public at large, or by the Defense Technical Information Center (DTIC) to the National Technical Information Services (NTIS).

This technical publication has been reviewed and is approved for publication.

Bryan E. Lilius

BRYAN E. LILIUS, Maj, USAF
Chief, Data Base Development Section
Reviewing Officer

FOR THE COMMANDER

Walter S. Burgmann

WALTER S. BURGMANN
Scientific and Technical Information
Officer (STINFO)

22 SEP 1980

UNCLASSIFIED

04/01

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER USAFETAC/TN-80/003	2. GOVT ACCESSION NO. AD-A096	3. RECIPIENT'S CATALOG NUMBER 796
4. TITLE (and Subtitle) BIVARIATE NORMAL WIND STATISTICS MODEL: User's Manual		5. TYPE OF REPORT & PERIOD COVERED Technical Note 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Benjamin Novograd, 2Lt, USAF		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS USAF Environmental Technical Applications Center Data Base Development Section Scott AFB, IL 62225		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS USAF Environmental Technical Applications Center Aerospace Sciences Branch Scott AFB, IL 62225		12. REPORT DATE September 1980 13. NUMBER OF PAGES 30
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Bivariate normal, computer programs, computer program documentation, meteorology, models, wind, wind direction, wind models, wind speed, wind statistics, wind velocity, vector wind models.

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

User instructions, sample input, sample output, and processing times are provided for USAFETAC/DND's wind statistics model. This model's basic input consists of five wind statistics: the means and standard deviations of the zonal and meridional wind components, and the correlation coefficient of these components. The model uses a bivariate normal distribution of these wind components to generate its output. The model's users can interactively select one or several of its output options. Each option generates (Cont'd)

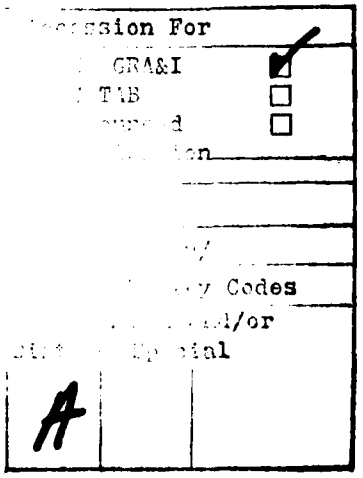
DD FORM 1 JAN 73 1473

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

20. ABSTRACT (Cont'd):

a different type of output. The available options include: points on an elliptical probability contour, the probability of a range of wind directions, the probability of a range of wind speeds, the joint probability of a range of wind speeds/and directions, new basic wind statistics using a rotated coordinate system, and the conditional probability of a range of wind speeds given a wind direction.



USER'S MANUAL

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

SECTION 1.0 GENERAL

1.1 Purpose of the User's Manual. This user's manual for the wind statistics program (DNDWST) provides the information necessary to effectively use the program.

1.2 Project References.

1.2.1 Project Request. The Space and Missile Test and Evaluation Center (SAMTEC) sent a project request to the USAF Environmental Technical Applications Center (USAFETAC) on 10 March 1978 describing the work required in accordance with AWSR 105-18. The USAFETAC project number assigned for the development of this program was 1893, task 01.

1.2.2 Documentation Concerning Related Projects. NASA TM X-73319, "Vector Wind and Vector Wind Shear Models," by O. E. Smith, contains a description of the equations used in the program and outlines the theory involved.

1.2.3 Documentation Standards and Specifications. The documentation complies with DOD Standard 7935.1-S, Automated Data Systems Documentation Standards, dated 13 September 1977.

1.2.4 Programming Conventions. American National Standards Institute (ANSI) FORTRAN programming conventions have been adhered to, except in the following cases:

a. Literals within FORMAT statements are written inside apostrophes instead of using the "H" (Hollerith) format code.

b. The integer variable "ITERM", which is always set to -1, is the FORTRAN logical unit for all input and output. This feature allows proper transfer of data across the ARPA network.

c. Free field formats, such as "2I" for two integers and "1F" for one real number, are occasionally used to give the user more flexibility when typing an input line.

1.3 Terms and Abbreviations

ARPA: Advanced Research Projects Agency

BB&N: Bolt, Beranek & Newman, Inc.

Bivariate Normal: A commonly used statistical distribution which is specified by the means, standard deviations, and correlation coefficient of two normally distributed variables.

DEC: Digital Equipment Corporation.

Meridional Component: The north/south component of the wind.

Percentile Wind Speed: A wind speed which is greater than or equal to the actual wind speed for a given percentage of observations. For example, if a 95th percentile wind speed is 50 knots, one would expect 95 percent of the observed wind speeds to be less than or equal to 50 knots.

Scalar Wind Speed: The observed wind speed, i.e., how fast the air is actually moving.

Wind Speed Units: Any type of wind speed can be used with this program. However, the units used for the wind speed and the velocity must be consistent throughout the program; for example, if the standard deviations are in meters per second (MPS), then the u and v components must be in MPS, and a request for a wind speed range will also use MPS.

Zonal Component: The east/west component of the wind.

1.4 Security and Privacy. This manual and the program that it describes are unclassified and can be released to the public. No privacy restrictions are associated with the use of this program.

SECTION 2.0 SYSTEM SUMMARY

2.1 System Application. The wind statistics program provides the user with information relating to the probabilities of various ranges of wind directions and wind speeds, using an assumed bivariate normal distribution of the zonal and meridional components of the wind. It allows the user to obtain probabilities of extreme event ranges (for example, extremely high or low wind speeds) which cannot be computed easily and accurately by direct access to meteorological data. This program can also recompute a set of basic wind statistics using a rotated set of coordinates, such as cartesian coordinates with one axis oriented along the azimuth of a flight path.

2.2 System Operation. Users (who are typically USAFETAC analysts) must first obtain a set of five basic wind statistics (means and standard deviations of the zonal and meridional components and their correlation coefficient) for the station(s) of interest before accessing the program. The "Uniform Summary of Winds Aloft Observations" data summaries, produced by USAFETAC, contain these basic statistics for several hundred upper-air observation stations, calculated by month of the year and season for various altitudes. These statistics are then input to the program, after which the appropriate choice of option(s) causes the program to print the desired information. The output may also be generated in a form suitable for transfer across the ARPA network or on tape. The overall functional diagram is shown schematically in Figure 1.

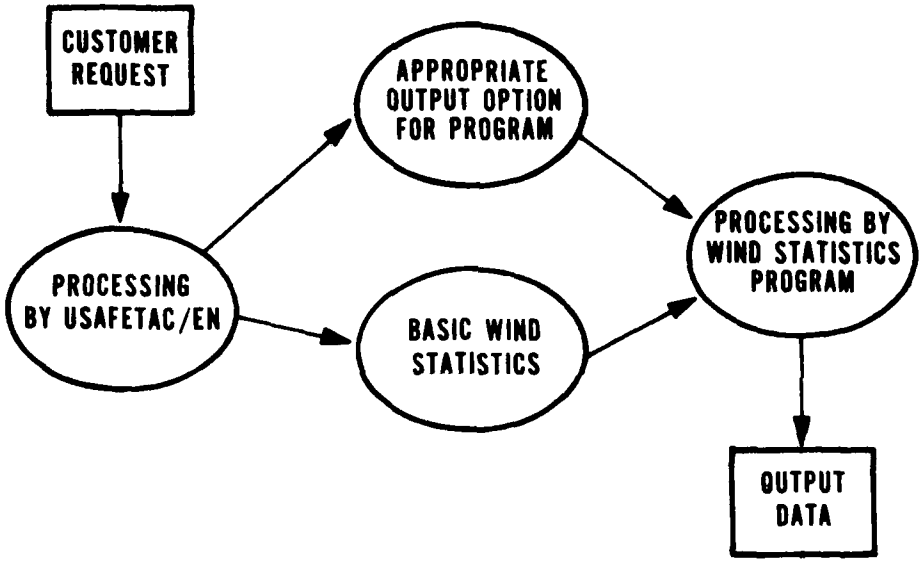


Figure 1. Overall Functional Diagram.

2.3 Program Configuration. The wind statistics program was designed for a DEC-10 computer. It presently operates on Bolt, Beranek and Newman's system "B" (BBNB) on the ARPA network. Changing the nonstandard items listed in Section 1.2.4 of this manual to ANSI Standard FORTRAN will effectively make this program compatible with other FORTRAN compilers.

The configuration necessary for a computer to use this program typically requires a FORTRAN compiler, linking loader, and interactive real-time input/output capability.

2.4 Program Organization. The program consists of a main program, seven subroutines, and eight functions. The main program solicits and controls all input data, and checks this data for obvious errors. Most of the output to the user's terminal or CRT is also controlled by the main program. The numerical calculations are performed by the various functions and subroutines; the number and name of subprograms involved depends on the type of output requested by the user. Some of the subroutines and functions are accessed indirectly by other subprograms. The calling structure of the main program and subprograms is illustrated in Figure 2. The purpose of each subprogram is outlined in Table 1.

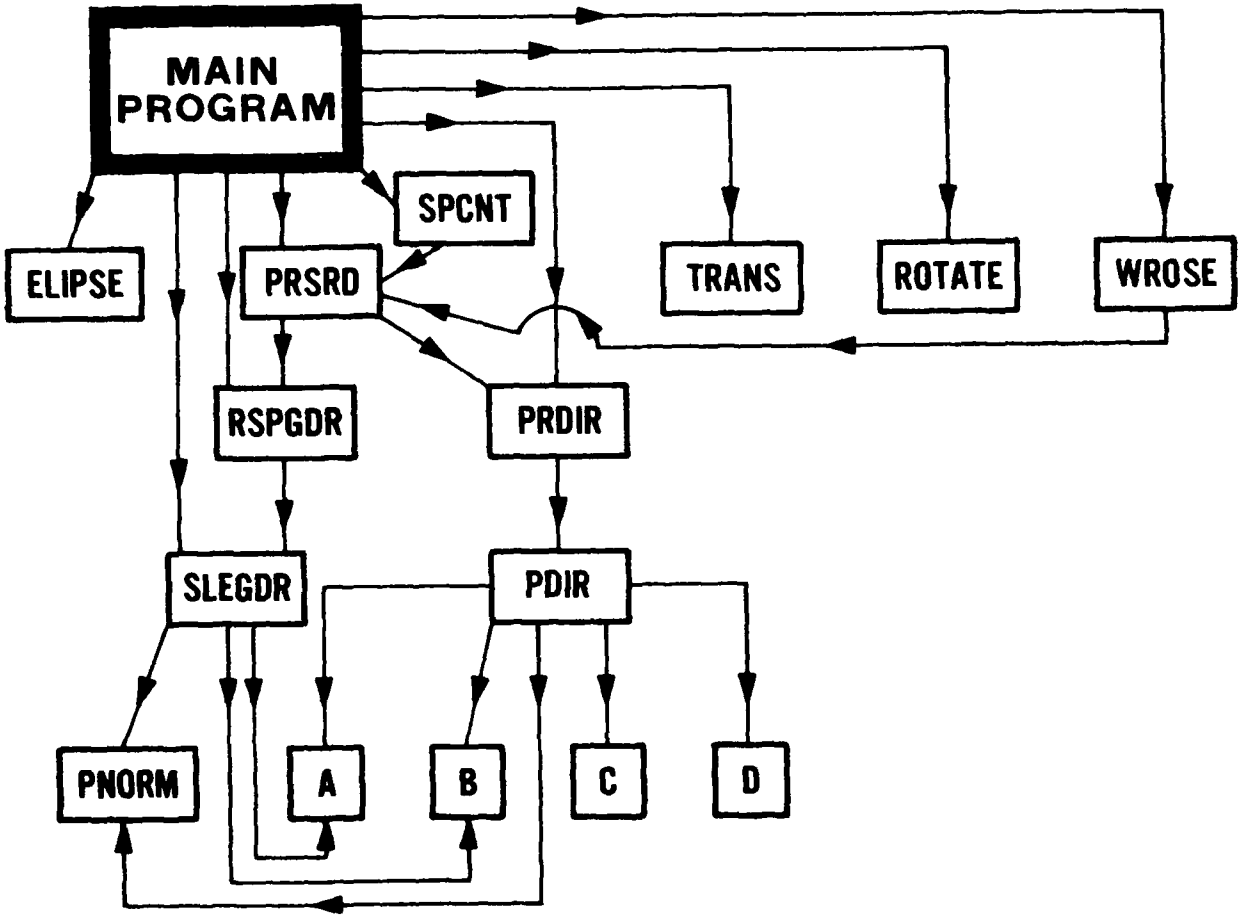


Figure 2. Calling Structure of the Main Program and Subprograms.

TABLE 1. PURPOSE OF THE SUBPROGRAMS

Subprogram	Purpose
Subroutine ELIPSE	Calculates and prints sets of points located on an elliptical probability contour.
Subroutine PRSRD	Computes the probability of the wind being within specified range of speeds and a specified range of directions.
Subroutine ROTATE	Calculates a new set of basic wind statistics based on a rotation of the X-Y axes through a given angle.
Subroutine RSPGDR	Gives the (conditional) probability of a specified range of wind speeds when the wind direction is known.
Subroutine SLEGDR	Computes the (conditional) probability that the wind speed is less than or equal to a specified value at a single wind direction.
Subroutine SPCNT	Calculates percentile wind speeds by initially estimating an answer and then using the method of half intervals to get a final result.
Subroutine WROSE	Calculates and prints a table of probabilities of various ranges of wind directions and speeds.
Functions A, B, C, D	These functions correspond to the terms "A", "B", "C", and "D" in Equation (32), (33), and (36) of NASA TM X-73319. Each of these terms is coded as a separate function to insure compatability with this document.
Function PDIR	Gives the probability density function for a specific wind direction.
Function PNORM	Computes the probability density for the normal distribution at a specified point.
Function PRDIR	Computes the probability of a specified range of wind directions.
Function TRANS	Modifies the input wind direction(s) so that all wind velocity vectors point away from the origin.

2.5 Performance

2.5.1 Overall Performance Capabilities. The wind statistics program can give the user the probability of a wide variety of wind speed and/or direction ranges. These ranges are subject to certain limitations imposed by the internal accuracy of the program, input/output formats, and the numerical approximations used in calculating certain types of probabilities. These limitations are discussed in greater detail in Section 2.5.3. All users of this program should also remember that the program uses an assumed bivariate normal distribution of the zonal and meridional wind components to calculate its results. The accuracy of the data output by this program depends to a large extent on how well the statistics of the actual wind "fit" the bivariate normal distribution. The accuracy of this distribution's fit varies with altitude and location; this variation, and some methods of determining how accurate this distribution is, will be dealt with in detail in a future USAFETAC technical note.

2.5.2 Response Time. The response time of this program depends on the processing time required by the option(s) being used and also on the number of users concurrently running other programs on BBN's system-B. If the usage of BBN's system-B is unusually heavy, all the printout produced by the program will be slowed and delays up to several minutes in length may occur. Waiting times are generally proportional to the CPU time required by an individual program option. The response time of any given option will be several times longer during periods of heavy BBNB usage. The time lag between user input and program output may approach 5 minutes for some options during periods of extremely heavy machine use. The CPU times required by the different options are discussed in Section 2.5.5.

2.5.3 Input/Output Limitations. The input and output limitations existing in the wind statistics program fall into two categories: limitations due to formats, and truncation errors inherent in the calculations producing the output. The limitations which apply to specific options are listed below.

a. The permissible range of output data points in option #1 (points on an elliptical probability contour) is -99.99 to 999.99 wind speed units. Data values with absolute values less than 0.001 are shown as zero. Identical restrictions apply to the extreme values of x and y printed by this option.

b. All probabilities output by options 2, 3, 4, and 5 are limited to the range $0<x<1$ where x is the output probability value. The probabilities whose absolute value is less than 0.0001 are shown as zero.

c. The wind speeds used as input to options 3, 4, and 5 should be within the range of 0 to 500 wind speed units. Values outside this range may cause unpredictable error conditions and abort the program.

d. The basic wind statistics output by option #6 (involving rotation of coordinates) have several limitations. The mean wind components printed must be smaller than 10^5 units and larger than 10^{-4} units; wind component values with an absolute value of less than 0.01 units are printed as zero. The correlation coefficient printed appears as zero if its absolute value is less than 0.001.

e. Wind speeds output by option #8 must be smaller than 10^5. Speeds smaller than 0.001 are printed as zero.

f. Probabilities output by option #9 are affected by the restriction given in a. above with one exception: the number output for the total probability may be slightly larger than 1. This number will almost always be between 0.999 and 1.001.

Several general limitations exist in the program. These limitations apply in addition to the limitations given for specific options. The probability of a range of directions is calculated internally in the program to a precision of 10^{-5}, while the probability of a range of speeds or a range of speeds and directions is calculated to a precision of 10^{-4}.

2.5.4 Error Detection Capabilities. The wind statistics program is capable of detecting several types of input errors. The program checks all input speeds for negative values; values less than zero produce the message

"ONE OR MORE OF THE INPUT SPEEDS ARE NEGATIVE"

after which the user is asked to input the speeds again. Similar consequences result when a user tries to input a negative standard deviation or a correlation coefficient which is outside its legal range (-1 to +1). An input percentile value for option #8 which is negative, zero, or larger than or equal to 100 will also produce a warning message and a request to input the data again. The program will reply to an illegal option number (less than 0 or greater than 9 by asking the user if the program should be stopped. A "yes" reply stops the program; a reply of "no" allows the user to input a new option number.

2.5.5 Processing Times. The CPU time used by this program depends primarily on the output options used by the analyst. The total CPU time for a given run can be calculated aproximately by adding the time required to print error messages, the time required to start and stop the program, and the time required for each option used. All CPU times given are valid for a DEC-10 computer.

The CPU time required to start the program, input a set of basic statistics, and stop it is about 0.5 sec. This represents unavoidable "overhead" time. An additional 0.9 sec is required to print the optional informative summary of the various available output options. Each error message also requires about 0.2 seconds to print.

Typical CPU times for the various options are as follows:

a. Option #1 (points on an elliptical probability contour) has CPU requirements which depend on the number of points generated. Ten sets of points require about 0.8 seconds, 50 sets require about 2.3 seconds, and 100 sets require about 4.5 seconds.

b. Option #2 (the probability of a range of wind directions) requires about 0.6 seconds of CPU time.

c. Option #3 (the probability of range wind speeds) requires anywhere from 2 to 15 seconds of CPU time. Small ranges of speeds are processed relatively rapidly.

d. Option #4 (the probability of a range of wind speeds and directions) uses from 4 to 15 seconds of CPU time, depending on the size of the range involved.

e. Option #5 (the probability of a range of wind speeds given a wind direction) uses about 0.5 seconds of CPU time.

f. Option #6 (rotation of the coordinate system) uses approximately 0.2 seconds of CPU time.

g. Option #7 (input of new basic parameters) requires 0.2 seconds of CPU time.

h. Option #8 (percentile windspeeds) uses larger amounts of CPU time. Typical CPU times for this option range from 12 to 25 seconds.

i. Option #9 (probability tables for wind direction and speed ranges) is the most time consuming option in this program. Typical CPU times for this option range from four to six minutes.

2.5.6 Flexibility. The program is designed to allow additional output options to be included at a later date. For example, some possible additional options include synthetic vector wind profiles, vector wind shear probabilities and the modulus of the vector wind shear. These additional options would use some of the subprograms already coded in the programs and "build" on their "foundation." Each output option is presently controlled by one segment of the main program; additional options would require additional segments of code in the main program and one or more additional subroutines.

2.6 Data Base. None required for this program.

2.7 General Description of Inputs, Processing, and Outputs

2.7.1 Inputs. All input to the program is typed on a terminal or CRT. The user must have the five basic wind statistics (mean zonal and meridional wind components, their standard deviations, and correlation coefficient) available for input to the program before running it. The users, typically USAFETAC analysts, should also determine in advance which option(s) are appropriate for their work. For example, option #3 would be appropriate to answer the question, "what is the probability of a wind speed greater than 20 knots?" A list of output options, option numbers, and descriptions of the resulting output are given in Section 3.2. The user should then get the reference information required for these option(s); for example, the number of sets of points to be given by option #1 or the wind direction range for option #2. Details on the type and nature of reference information required for each option are given in Sections 3.2.1 and 3.2.3.

2.7.2 Processing. The user begins by typing a set of five basic wind statistics. The program will then ask the user for an option number. After the user types the appropriate digit, the program asks for reference information. The calculation and printing of output takes place after all the reference data has been input. The program then asks for another option number. The user can then stop the program (option #0), change the basic wind statistics (option #7), or use another option. The program continues in this fashion until the user inputs an illegal option number and indicates that a program stop is desired, or until the program is stopped by option #0. This process is shown in Appendix A.

2.7.3 Output. All output is normally sent to the user's input device (a terminal or CRT). The format, type, and content of the output will vary depending on the option selected. The types and formats of output are described in detail in Section 3.3.1.

SECTION 3 STAFF FUNCTIONS RELATED TO TECHNICAL OPERATIONS

3.1 Initiation Procedures. The user should log into the ETAC-DN directory at BBNB on the ARPA network. USAFETAC users requiring assistance with ARPA access procedures should refer to the USAFETAC ARPA user's guide. Typing "DNDWST" after the prompt will start the program. The program will reply with

"*** USAFETAC/DND WIND STATISTICS PROGRAM ***"

to indicate that the program has begun execution.

3.2 Staff Input Requirements. The user inputs data interactively to this program via a terminal or CRT. The program always explicitly asks for any input required at the appropriate times during its execution.

3.2.1 Input Contents and Format. The format of data input to the program depends on the type of data the program is requesting. After the printout of its title, the program will ask the user if he wants information on the available output options. A "Y" input produces a list of these options, after which the program asks for a set of five basic wind statistics. Typing anything other than a "Y" allows the program to go directly to this step. The basic wind statistics must be typed on one line in the following order:

a. The mean zonal component of the wind, must be typed as a real number (with a decimal point). Leading zeros may be omitted.

b. The standard deviation of the zonal component of the wind, "STDEVX," must be a positive real number.

c. The mean meridional component of the wind, must be a real number.

d. The standard deviation of the meridional component of the wind, "STDEVY," must be a positive real number.

e. The correlation coefficient of the two components of the wind, indicated as "CORR. COEFF." in the program's request for input, must be a real number between -1 and 1.

These five values must be typed in separated by commas and without intervening blanks. The total number of digits in any input value should not exceed eight; any excess digits will be truncated after input to the program is complete.

The program asks for an option number after the basic statistics have been input. This number should be a single digit from 0 to 9. The program will accept larger numbers and give a warning message; the use of a decimal number will give erratic results. The input contents and format used with the individual program options are shown in Table 2.

TABLE 2. INPUTS TO THE PROGRAM OPTIONS.

Option Number	Type of Input
1	a. A decimal probability value between 0 and 1 b. The number of points required (an integer)
2	Two decimal numbers indicating a range of directions
3	Two decimal numbers indicating a range of speeds
4	a. Two decimal numbers indicating a range of directions b. Two decimal numbers indicating a range of speeds
5	a. A single decimal number indicating a direction b. Two decimal numbers indicating a range of speeds
6	A decimal number indicating an angle of rotation
7	Five decimal numbers (basic wind statistics). The second and fourth numbers (standard deviations) must be positive; the fifth number (correlation coefficient) must be between -1 and 1.

8	A decimal percentile value between 0 and 100.
9	a. Four sets of alphanumeric characters describing the period of record, layer or level, location, and wind speed units associated with the probability table being printed. The maximum lengths of these four character strings are 20, 30, 25, and 10 characters, respectively. b. A character (Y or N) indicating the users choice of where the output should go. If the user replies with "Y", two more inputs are required: c. A set of up to five alphanumeric characters indicating the file name to be used for the output produced by this option, and d. Another character (Y or N) indicating whether or not the program should stop after completing this option.

3.2.2 Composition Rules. The programming language used (FORTRAN), together with the input formats, impose certain limits on the composition of input. These limits are as follows:

a. Numbers input to the program may not include embedded blanks.

b. The characters which may be typed in reply to a request for numerical data are limited to the digits 0-9, periods, commas, the plus and minus signs. Typing any other character will abort the program.

3.2.3 Input Vocabulary. Only one set of codes is used in the wind statistics program. The output options are designated by numbers from 0 to 9. These options are listed in Table 3.

TABLE 3. PROGRAM OPTIONS

Option Number	Description of the Resulting Output
0	Stops the program
1	Prints points defining an elliptical probability contour. A wind vector with the given basic wind statistics will have a probability, equal to a value specified in the user's input, of being inside this elliptical contour.
2	Prints the probability of a range of wind directions. The range is always taken to be going clockwise from the first direction given to the second one. Directions are always in degrees.
3	Prints the probability of a range of speeds. The wind speed units used must be identical to those used for the five basic wind statistics. The probability of a wind speed outside the input range will be given if the larger of the two speeds defining the range is input first.
4	Prints the joint probability of a range of directions and range of speeds. The conventions used in determining ranges are identical to those listed for options 2 and 3.
5	Prints the conditional probability of a range of wind speeds when the wind direction is known.
6	Rotates the coordinate system used for the basic wind statistics and prints the new basic statistics. These new values are then used in all program calculations until changed again by the use of options 6 or 7.

7	Allows the user to input a new set of basic wind statistics. The new statistics are then used in all subsequent program processing until they are changed again by options 6 or 7.
8	Prints wind speed percentiles. The wind speed will have a probability, equal to a value input by the user, of being smaller than or equal to the wind speed printed by this option.
9	Prints a table containing the probabilities of various wind speed and direction intervals. This table is labeled with the station location, level, period of record, and wind speed units input by the user. The wind direction ranges used by this option correspond with, and are centered on, the standard directions in a wind rose: N, NNE, NE, ENE, etc. The wind speeds are broken down into ranges of less than 1 unit (calm), 1-10 units, 10-20, 20-30, 30-40, 40-50, 50-60, 60-75, 75-100, 100-150, 150-200, and greater than 200 units.

3.2.4 Sample Inputs. A sample user reply to a program request for basic statistics

"INPUT MEAN X,STDEVX,MEAN Y,STDEVY, CORR. COEFF." would be "1.3,3.4,-22.7,6.8,.2312"

where	1.3	= mean zonal wind component
	3.4	= standard deviation of the zonal wind component
	-22.7	= the mean meridional wind component
	6.8	= standard deviation of the meridional wind component
	.2312	= the correlation coefficient of the two wind components

The type and format of other inputs to the program depend on the option being used. Some sample inputs for each option which asks for input are given below:

a. Sample input for option #1. The user's reply to this option's initial request "INPUT PROBABILITY VALUE" is .23 indicating that the 23 percent probability contour is needed. The next request is "INPUT THE NUMBER OF X-YLOW-YHIGH SETS DESIRED." Typing "25" asks this option to print out 25 sets of points.

b. Sample input for option #2. The user's reply to this option's request "INPUT RANGE OF DIRECTIONS" is "125.3,178.6" which specifies the range of directions from 125.3° to 178.6°. Typing "330.,30." instead would specify the range of directions from NNW through N to NNE.

c. Sample input for option #3. Typing "3.,6." in response to this option's request "INPUT RANGE OF SPEEDS," tells this option to get the probability of a wind speed between 3 and 6 wind speed units. Typing in "10.,0." instead, asks this option to generate the probability of a wind speed greater than 10 wind speed units (corresponding to the range outside 0-10 units.)

d. Sample input for option #4. This option solicits input with the statement "INPUT RANGE OF DIRECTIONS." The user types in "30.,63.5". This option then asks for more input by printing out "INPUT RANGE OF SPEEDS." The user then types in "0.,33.5". The program will then calculate the joint probability of a wind direction between 30 and 63.5 degrees (NNE to approx. ENE) and a wind speed below 33.5 units.

e. Sample input for option #5. This option prints "INPUT DIRECTION." The user then types in "225.". This option then prints "INPUT RANGE OF SPEEDS." The user then types in "0.,33.5.". The program will then calculate the probability that the wind speed will be equal to or less than 33.5 units when the wind direction is 225 degrees (SW).

f. Sample input for option #6. This option asks for input with the statement "INPUT ANGLE OF ROTATION." Typing "15." will indicate to the program that a counterclockwise rotation of 15° is required.

g. Sample input for option #8. This option states, "INPUT THE REQUIRED PERCENTILE." Typing "88.0" asks the program to compute the 88th wind speed percentile value.

h. Sample input for option #9. This option requires several lines of input. The lines enclosed in quotes, below, are entries typed by the user. The other lines are typed by the program.

```
INPUT THE PERIOD OF RECORD - UP TO 20 CHARACTERS
"JAN 70 - DEC 74"
INPUT THE LEVEL OR LAYER - UP TO 30 CHARACTERS
"4500 FEET - 5000 FEET"
INPUT THE LOCATION - UP TO 25 CHARACTERS
"ANDREWS AFB"
INPUT THE WIND SPEED UNITS - UP TO 10 CHARACTERS
"MPH"
DO YOU WANT THE PROBABILITY TABLE WRITTEN OUT TO A FILE? (Y=YES, N=NO)
"Y"
PLEASE INPUT THE FILENAME - UP TO 5 CHARACTERS
"NNNNN"
WOULD YOU LIKE THE PROGRAM TO STOP AFTERWARD? (Y=YES, N=NO)
"N"
YOUR PROBABILITY TABLE WILL BE SENT TO FILE NNNNN.DAT
```

Option #7 asks for another set of basic statistics, while option #0 does not require input.

3.3 Output Requirements. All the output appears on the user's input device (normally a CRT or terminal). The output varies depending on the option number selected. Option #1 generates a set of points for plotting a probability contour. Options 2, 3, 4, and 5 generate probabilities of wind speed and/or wind direction ranges using various conditions. Option 6 prints values of basic wind statistics using a rotated coordinate system, and Option 8 prints wind speed percentiles. Option #9 generates a table of probabilities of ranges of wind directions and speeds.

3.3.1 Output Formats. The format of output varies according to the option being used. The different formats are listed below.

a. Option #0 prints

```
STOP
END OF EXECUTION
CPU TIME:  b:bb.bb
ELAPSED TIME:  e:ee.ee
```

where b:bb.bb is the CPU time used during the execution of the program, and e:ee.ee is the actual time elapsed since the program was started. Both times are in minutes, seconds, and hundredths of seconds. A program stop due to the use of an illegal option number prints the same type of output.

b. The output produced by option #1 begins with a header, "X YLOW YHIGH" and then continues with lines formatted in such a way that the appropriate information is positioned below each header word. The output lines have the format, XXXX.XXXX.YYYY.YYYY ZZZZ.ZZZZ where the values XX...., YY...., and ZZ.... correspond to x1, y1, and y2 where (x1,y1) and (x1,y2) are the intersection points of the line x = x1 with the ellipse to be plotted. This setup is shown graphically in Figure 3.

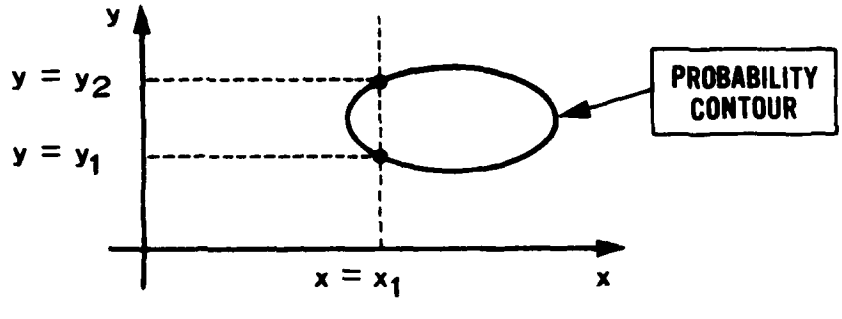


Figure 3. Plotting Points Output by Option #1.

One set of points is printed per line, so that the number of lines printed with this format is equal to the number of point sets specified by the user. The reference information printed at the end of this option's output consists of:

EXTREME VALUES OF X: xxxx.xxxx xxxx.xxxx
EXTREME VALUES OF Y: yyyy.yyyy yyyy.yyyy

where xxxx.xxxx and yyyy.yyyy are the largest and smallest values of X and Y on the elliptical contour.

c. Option #2 prints a single line of output with the format

PROBABILITY OF GIVEN WIND DIRECTION RANGE .pppp

where .pppp is the probability asked for by the user (always between 0 and 1).

d. Option #3 prints a single line of output with the format

PROBABILITY OF GIVEN RANGE OF SPEEDS .pppp

where .pppp is the probability of the range of speeds given.

e. Option #4 prints a single line of output with the format

PROBABILITY OF GIVEN RANGE OF SPEEDS AND DIRECTNS. .pppp

where .pppp is the joint probability of the range of directions and speeds given by the user.

f. Option #5 prints a single line of output with the format

PROBABILITY OF GIVEN RANGE OF SPEEDS AT GIVEN DIRECT .pppp

where .pppp is the probability of the speed range specified when the wind direction is equal to the specified value.

g. Option #6 prints a single line of output with the format

NEW STDEVX: xxxx.xx NEW STDEVY: yyyy.yy

where xxxx.xx and yyyy.yy are the standard deviations of the zonal and meridional coordinates in the rotated coordinate system. The option prints

NEW MEAN X: mmmm.mm NEW MEAN Y: nnnn.nn NEW CORR: c.cccc

where mmmm.mm and nnnn.nn are the means of the zonal and meridional wind components in the rotated coordinate system, and c.cccc is the new correlation coefficient.

h. Option #7 does not print any data.

i. Option #8 prints a single line of output with the format

CORRESPONDING WIND SPEED: pppp.pp

where pppp.pp is the percentile value of the wind speed asked for by the user.

j. Option #9 prints one page of output, containing a table of probabilities of various ranges of wind directions and speeds. An example is shown in Appendix A.

3.3.2 Sample Output. Appendix A shows an example of program usage in which an analyst uses every possible option. Details on this example are given in that section of the manual.

3.4 Utilization of System Outputs. The output produced by this program is typically used to answer customer requests for probabilities of wind direction intervals and/or wind speed ranges or wind speed percentiles.

3.5 Recovery and Error Correction Procedures

No explicit restart capability is provided. The standard BBNB detaching capabilities apply: a user can sometimes continue running the program from where it was interrupted if the interruption was due to a connection failure, local system problems, etc. The user can also explicitly abort the program using a control "C" if repeated errors occur or if the program is running extremely slowly due to heavy machine usage, and then start again from the beginning.

A user can "detach" the program if he is using option #9 and sending his output to a data file. This procedure is recommended in cases where machine usage is substantial and this option may require up to a half hour to complete its output. The user should than reattach to the program at a later time, preferably about a half hour after detaching from it. Option #9 will then indicate if its output to the data file is complete. Detaching the program while using any other option causes the program to suspend execution and wait until the user reattaches to it.

Erroneous basic wind statistics can be corrected by using option #7 to input the correct set of values. The original basic statistics can also be retrieved if a faulty change of coordinates occurs in option #6. This is done by using that option again with an angle of rotation equal to the previous value input multiplied by -1. The user can run any other option repeatedly using different input values if its initial results were wrong because of erroneous input.

Appendix A

SAMPLE RUN OF THE WIND STATISTICS PROGRAM

The numbers in the following description correspond to the sections indicated on the sample run.

1. The user begins by starting the program with DNDMST. The program then prints at the user's request, a list of the available output options. It then asks the user to input a set of basic wind statistics.

2. The user decides to get 15 points on the 55% probability contour and invokes option #1. Note that the first and last point set are on the left and right tips of the ellipse; their values of YLOW and YHIGH are identical.

3. Option #2 is used to get the probability of a wind direction range from 270° (W) through N to 30° (NNE).

4. Option #3 is used to get the probability of a wind speed range from 10 to 30 wind speed units.

5. The user selects option #4 and gets the joint probability of a wind speed between 10 and 25 units and a wind direction between 100 and 200 degrees.

6. Option #5 gives the user the probability of the wind speed being between 5 and 50 units, assuming a south wind (180°).

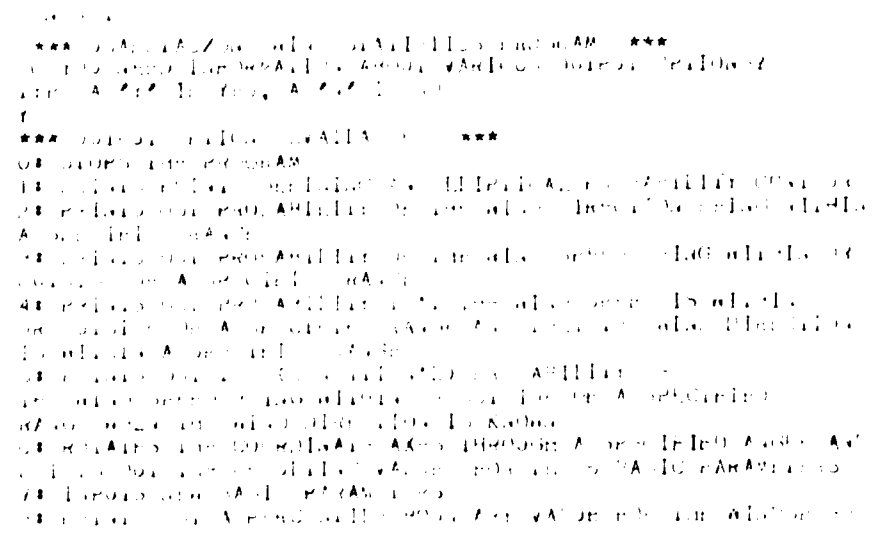
7. It's time for a 20 degree counterclockwise rotation of coordinates. Option #6 does this and prints new basic statistics.

8. The user invokes option #7 and inputs a new set of basic wind statistics.

9. Option #8 is used to get the 88th wind speed percentile. The wind speed will be below this value 88 percent of the time.

10. The user generates a table of probabilities for various ranges of wind directions and speeds using option #9. The location involved was Andrews AFB and the period of record used was January 1960 to December 1974. The wind speed units used were miles per hour. Note that the total probability figure is not exactly 1 (in this case, the result is 1.0001) due to truncation and round off errors.

11. The user stops the program by using option #0. Total CPU time used was about 3 minutes and 47 seconds and the session lasted about 17 minutes.



```
?# PRINTS OUT A PROBABILITY TABLE FOR THE WIND DIRECTION AND SPEED
INPUT MEAN X,STDEVX,MEAN Y,STDEVY,CORR. COEF .
12.25,30.44,-3.55,25.64,.3322
 INPUT DESIRED OPTION
1
 INPUT PROBABILITY VALUE
.95
INPUT NUMBER OF X-YLOW-YHIGH SETS DESIRED
15
     X          YLOW        YHIGH
---------  ---------  ---------
 -26.2180  -14.3140   -14.3140
 -20.7225  -28.5150     2.9655
 -15.2271  -33.6274    10.1573
  -9.7317  -34.7815    15.3779
  -4.2363  -35.7761    19.4493
   1.2592  -35.9134    22.6625
   6.7546  -35.3362    25.1607
  12.2500  -34.1119    27.0119
  17.7454  -32.2607    28.2362
  23.2408  -29.7625    28.8134
  28.7363  -26.5498    28.5751
  34.2317  -22.4799    27.5815
  39.7271  -17.2503    25.5274
  45.2225  -10.0655    21.4180
  50.7180    7.2106     7.2174
 EXTREME VALUES OF X:   -26.2180   50.7180
 EXTREME VALUES OF Y:   -35.9521   25.8521
 INPUT DESIRED OPTION
2
INPUT RANGE OF DIRECTIONS
270.,30.
PROBABILITY OF GIVEN WIND DIRECTION RANGE .4049
 INPUT DESIRED OPTION
3
INPUT RANGE OF SPEEDS
10.,30.
PROBABILITY OF GIVEN RANGE OF SPEEDS .3557
 INPUT DESIRED OPTION
4
INPUT RANGE OF DIRECTIONS
150.,210.
INPUT RANGE OF SPEEDS
10.,30.
PROBABILITY OF GIVEN RANGE OF SPEEDS AND DIRECTNS 0.1482
 INPUT DESIRED OPTION
5
INPUT DIRECTION
150.
INPUT RANGE OF SPEEDS
5.,30.
PROBABILITY OF GIVEN SPEED RANGE AT GIVEN DIRECT. .8397
 INPUT DESIRED OPTION
6
INPUT ANGLE OF ROTATION
20.
NEW STDEVX:  32.58 NEW STDEVY:  22.85
NEW MEAN X:  10.30 NEW MEAN Y:  -7.55 NEW CO (:  .1505
 INPUT DESIRED OPTION
7
INPUT MEAN X,STDEVX,MEAN Y,STDEVY,CORR. COEFF.
12.5,25.5,22.5,33.4,.2222
 INPUT DESIRED OPTION
5
INPUT THE REQUIRED PERCENTILE
```

```
CORRESPONDING WIND SPEED: 72.1676
 INPUT DESIRED OPTION
9
INPUT THE PERIOD OF RECORD - UP TO 20 CHARACTERS
JAN 1970 - DEC 1974
INPUT THE LEVEL OR LAYER - UP TO 30 CHARACTERS
4000 FEET - 4500 FEET
INPUT THE LOCATION - UP TO 25 CHARACTERS
ANDREWS AFB
INPUT THE WIND SPEED UNITS - UP TO 10 CHARACTERS
MPH
DO YOU WANT THE PROBABILITY TABLE WRITTEN OUT TO A FILE? (1=YES,0=NO)
0
```

ANDREWS AFB 4000 FEET - 4500 FEET JAN 1970 - DEC 1974

WIND SPEED - MPH

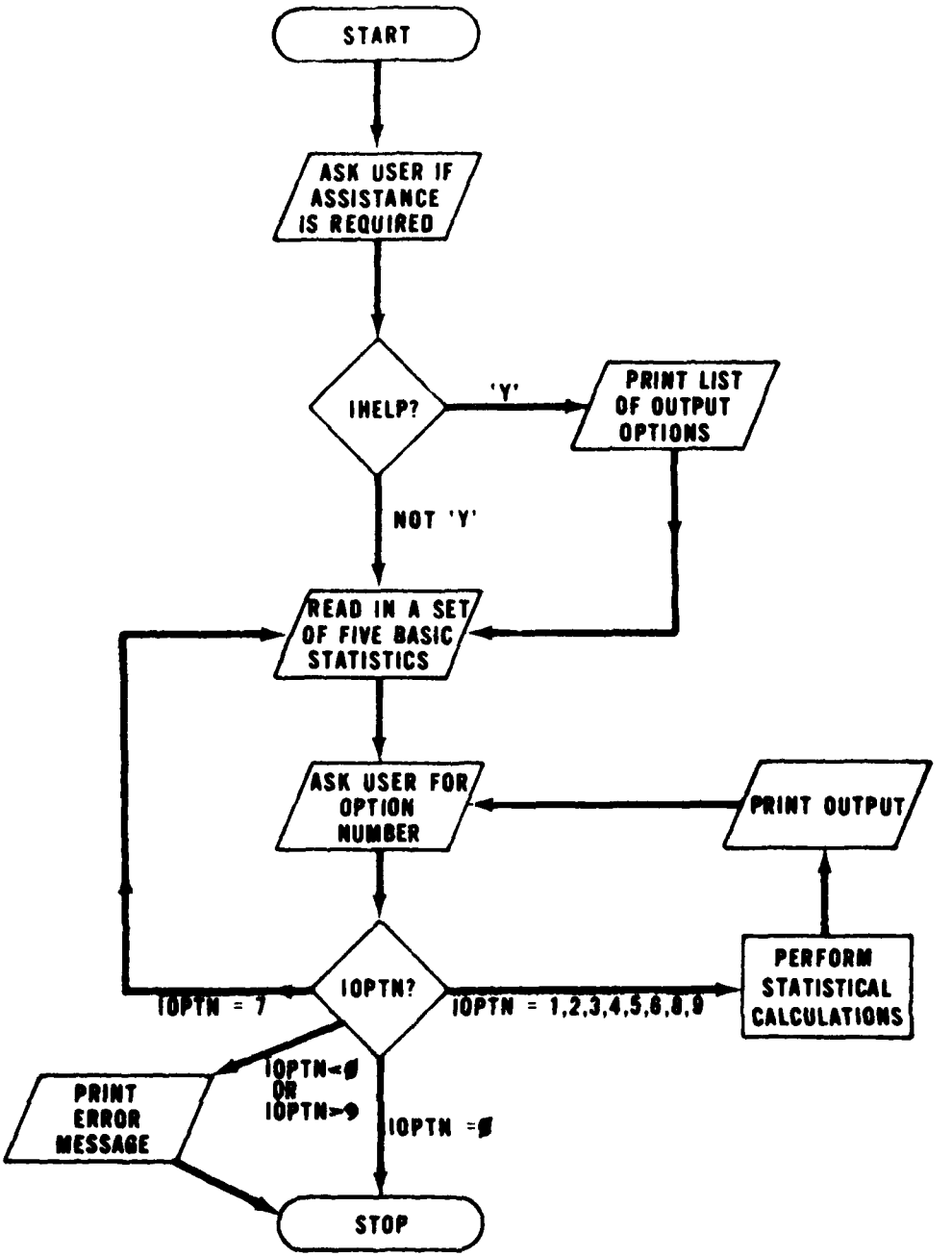
DIR	1-10	10-20	20-30	30-40	40-50	50-60	60-75	75-100	100-150	150-200	>200	TOTAL
N	.0031	.0099	.0162	.0204	.0215	.0197	.0222	.0169	.0041	.0000	.0000	.1341
NNE	.0031	.0107	.0184	.0249	.0280	.0277	.0347	.0313	.0199	.0001	.0000	.1591
NE	.0032	.0106	.0179	.0232	.0248	.0230	.0262	.0193	.0045	.0000	.0000	.1533
ENE	.0031	.0097	.0152	.0174	.0162	.0126	.0112	.0055	.0006	.0000	.0000	.0915
E	.0029	.0086	.0120	.0120	.0094	.0060	.0040	.0012	.0000	.0000	.0000	.0563
ESE	.0028	.0075	.0095	.0086	.0060	.0034	.0019	.0005	.0000	.0000	.0000	.0402
SE	.0026	.0067	.0080	.0059	.0047	.0026	.0015	.0004	.0000	.0000	.0000	.0336
SSE	.0025	.0061	.0072	.0063	.0044	.0026	.0017	.0005	.0000	.0000	.0000	.0318
S	.0025	.0057	.0066	.0059	.0044	.0029	.0021	.0003	.0000	.0000	.0000	.0309
SSW	.0024	.0054	.0062	.0054	.0040	.0026	.0019	.0009	.0000	.0000	.0000	.0299
SW	.0024	.0053	.0056	.0043	.0034	.0020	.0013	.0004	.0000	.0000	.0000	.0264
WSW	.0024	.0053	.0056	.0044	.0028	.0015	.0008	.0002	.0000	.0000	.0000	[illegible]
W	.0025	.0056	.0059	.0045	.0027	.0013	.0006	.0001	.0000	.0000	.0000	.0252
WNW	.0026	.0063	.0070	.0056	.0035	.0017	.0009	.0002	.0000	.0000	.0000	.0277
NW	.0027	.0073	.0092	.0084	.0061	.0035	.0022	.0006	.0000	.0000	.0000	.0402
NNW	.0029	.0086	.0125	.0136	.0121	.0091	.0078	.0037	.0004	.0000	.0000	.0709
CALM	.0005											
TOTL	.0441	.1195	.1634	.1723	.1561	.1224	.1211	.0829	.0201	.0001	.0000	1.0001

```
***  YOUR PROBABILITY TABLE IS READY  ***
 INPUT DESIRED OPTION
0
STOP

END OF EXECUTION
CPU TIME: 3:50.92 ELAPSED TIME: 24:27.51
EXIT.
```

Appendix B

WIND STATISTICS MODEL FLOW CHART



Appendix C

PROGRAM LISTING

```
C**
C*************************************************************************
C**
C*     PROGRAM ID - DNDWST
C*     PROGRAMMER AND ANALYST - 2LT NOVOGRAD, USAFETAC/DND
C*     CREATED ON - 15 MAY 79 FOR PROJECT 1893
C**
C*     VERSION - 1.0
C**
C*     DESCRIPTION - THIS PROGRAM INTERACTIVELY CALCULATES A VARIETY
C*     OF WIND RELATED STATISTICS AND PROBABILITIES, USING AN ASSUMED
C*     BIVARIATE NORMAL DISTRIBUTION OF THE ZONAL AND MERIDIONAL
C*     WIND COMPONENTS. ITS DATA BASE CONSISTS OF A SET OF FIVE
C*     BASIC STATISTICS WHICH DESCRIBE THE WIND AT A GIVEN ALTITUDE,
C*     LOCATION AND CLIMATOLOGICAL TIME PERIOD. THESE BASIC STATISTICS
C*     ARE THE MEANS AND STANDARD DEVIATIONS OF THE ZONAL AND MERIDIONAL
C*     WIND COMPONENTS, AND THEIR CORRELATION COEFFICIENT. THE USER
C*     SELECTS THE OPTION WHICH GENERATES THE PARTICULAR TYPE OF WIND
C*     STATISTICS DESIRED BY TYPING IN THE APPROPRIATE OPTION NUMBER.
C*     THE PERMISSIBLE OPTION NUMBERS, AND THE TYPES OF OUTPUT WHICH THEY
C*     GENERATE, ARE AS FOLLOWS
C**
C*       OPTION NUMBER            TYPE OF OUTPUT GENERATED
C*       -------------            ------------------------
C**
C*             1                  COORDINATES OF POINTS ON AN ELLIPTICAL
C*                                PROBABILITY CONTOUR
C**
C*             2                  PROBABILITY OF A RANGE OF
C*                                WIND DIRECTIONS
C**
C*             3                  PROBABILITY OF A RANGE OF WIND SPEEDS
C**
C*             4                  JOINT PROBABILITY OF A RANGE OF WIND
C*                                SPEEDS AND DIRECTIONS
C**
C*             5                  CONDITIONAL PROBABILITY OF A RANGE OF
C*                                WIND SPEEDS GIVEN A WIND DIRECTION
C**
C*             6                  NEW BASIC STATISTICS USING A ROTATED
C*                                COORDINATE SYSTEM
C**
C*             7                  NO OUTPUT GENERATED - ALLOWS USER TO
C*                                INPUT NEW BASIC STATISTICS DIRECTLY
C**
C*             8                  PERCENTILE WIND SPEEDS
C**
C*             9                  A TABLE OF JOINT PROBABILITIES
C*                                OF RANGES OF WIND DIRECTIONS AND SPEEDS.
C**
C*             0                  NO OUTPUT GENERATED - STOPS THE PROGRAM.
C**
C*     THE PROGRAM IS DESIGNED TO RUN IN AN INTERACTIVE ENVIRONMENT
C*     AND ALWAYS TYPES OUT A REQUEST FOR INPUT WHEN IT NEEDS IT.
C**
C*     METHOD - THE EQUATIONS AND THEORY USED TO DEVELOP THIS PROGRAM
C*     WERE TAKEN FROM NASA TM X-73319, "VECTOR WIND AND VECTOR WIND
C*     SHEAR MODELS. . . .", BY O.E. SMITH. ALL THE PAGE
C*     AND EQUATION NUMBERS GIVEN IN THIS PROGRAM'S DOCUMENTATION
C*     REFER TO THIS TECHNICAL MEMORANDUM. THE EQUATIONS USED TO GENERATE
C*     SETS OF POINTS ON AN ELLIPTICAL PROBABILITY CONTOUR (OPTION #1)
C*     ARE LISTED ON PP.11-12. THE PROBABILITY OF A RANGE OF WIND
C*     DIRECTIONS IS COMPUTED BY NUMERICAL INTEGRATION OF EQUATION
C*     (33). THE CONDITIONAL PROBABILITY OF A RANGE OF WIND SPEEDS
C*     GIVEN A WIND DIRECTION (OPTION #5) IS CALCULATED USING EQUATION
C*     (36). THE NUMERICAL INTEGRATION OF (36) OVER ALL DIRECTIONS
C*     IS USED TO COMPUTE THE PROBABILITY OF A RANGE OF SPEEDS (OPTION
C*     #3), AND SUCH AN INTEGRATION OVER A SPECIFIED RANGE OF DIRECTIONS
C*     GIVES THE JOINT PROBABILITY OF A RANGE OF SPEEDS AND DIRECTIONS
C*     (OPTION #4). THE CALCULATION OF NEW BASIC STATISTICS IN A ROTATED
C*     COORDINATE SYSTEM (OPTION #6) IS ACCOMPLISHED USING EQUATIONS (45)
C*     THROUGH (49). PERCENTILE WINDSPEEDS (OPTION #8) ARE COMPUTED USING
C*     THE METHOD OF HALF INTERVALS. THE PROBABILITIES WRITTEN OUT BY
C*     OPTION #9 ARE GENERATED USING REPEATED CALLS TO THE SUBROUTINE
C*     USED FOR OPTION #4.
C**
```

```
C*     REFERENCES - 1. NOVOGRAD, BENJAMIN B., 1980  USAFETAC      WIND
C*                  STATISTICS MODEL USERS MANUAL, USAFETAC TN 80-003.
C*                  2. SMITH, O.E., 1976  VECTOR WIND AND VECTOR WIND SHEAR
C*                  MODELS AT 0 TO 27 KM ALTITUDE FOR CAPE KENNEDY, FLORIDA,
C*                  AND VANDENBERG AFB, CALIFORNIA.
C**
C*     INPUT - A SET OF BASIC WIND STATISTICS, PLUS AN OPTION NUMBER AND ANY
C*     ADDITIONAL INFORMATION REQUIRED BY THE PARTICULAR OPTION(S) USED. DETAILS
C*     ARE GIVEN IN SECTION 3.2 OF THE USERS MANUAL.
C**
C*     OUTPUT - THE STATISTICS CALCULATED BY THE PARTICULAR OPTION SELECTED BY
C*     THE USER. DETAILS ARE GIVEN IN SECTION 3.3 OF THE USERS MANUAL.
C**
C*     SYSTEM SUBPROGAMS USED - COS, SIN, SQRT
C**
C*     USER SUBPROGRAMS USED - A, B, C, D, ELIPSE, PDIR, PNORM, PRDIR, PRSRD,
C*     ROTATE, RSPGDR, SLEGDR, SPCNT, TRANS, WROSE.
C**
C*     ESTIMATED CPU TIME - THE CPU TIME USED IS VARIABLE AND DEPENDS ON
C*     WHICH OUTPUT OPTION(S) ARE SPECIFIED BY THE USER. DETAILS ARE
C*     GIVEN IN SECTION 2.5.5. OF THE USERS MANUAL.
C**
C*************************************************************************
CCC
C    ***    MAIN PROGRAM    ***
CCC
      DIMENSION ILOCN(5),ILVLYR(6),IPOR(4),IWSU(2)
      COMMON /BLK1/ SQSTX,SQSTY,PROSTD
      COMMON /BLK2/ XBAR,YBAR
      COMMON /BLK3/ CORR,DENOM
      DATA ITERM,IYES/-1,'Y   '/
    1 FORMAT ('   *** USAFETAC/DND WIND STATISTICS PROGRAM  ***',/
CCC
C   **  ASK USER IF INFORMATION ABOUT OUTPUT OPTIONS IS NEEDED  **
CCC
     $' DO YOU NEED INFORMATION ABOUT VARIOUS OUTPUT OPTIONS? ',/
     $' TYPE A ''Y'' IF YES, A ''N'' IF NO')
      WRITE (ITERM,1)
   62 FORMAT(A4)
      READ (ITERM,62) IHELP
      IF (IHELP.NE.IYES) GO TO 70
CCC
C    *** THIS SECTION HELPS OUT A NEW USER ***
CCC
      WRITE (ITERM,4)
      WRITE (ITERM,44)
    4 FORMAT (' *** OUTPUT OPTIONS AVAILABLE   ***',/
     $' 0  STOPS THE PROGRAM',/
     $' 1  PRINTS POINTS DEFINING AN ELLIPTICAL PROBABILITY CONTOUR',/
     $' 2  PRINTS OUT PROBABILITY OF THE WIND DIRECTION BEING WITHIN',/
     $' A SPECIFIED RANGE',/
     $' 3  PRINTS OUT PROBABILITY OF THE WIND SPEED BEING WITHIN OR',/
     $' OUTSIDE OF A SPECIFIED RANGE',/
     $' 4  PRINTS OUT PROBABILITY THAT THE WIND SPEED IS WITHIN',/
     $' OR OUTSIDE OF A SPECIFIED RANGE AND THAT THE WIND DIRECTION',/
     $' IS WITHIN A SPECIFIED RANGE')
   44 FORMAT (' 5  PRINTS OUT THE (CONDITIONAL) PROBABILITY OF',/
     $' THE WIND SPEED BEING WITHIN OR OUTSIDE OF A SPECIFIED',/
     $' RANGE WHEN THE WIND DIRECTION IS KNOWN',/
     $' 6  ROTATES THE COORDINATE AXES THROUGH A SPECIFIED ANGLE AND ',/
     $' POINTS OUT THE RESULTING VALUES FOR THE 5 BASIC PARAMETERS',/
     $' 7  INPUTS NEW BASIC PARAMETERS',/
     $' 8  PRINTS OUT A PERCENTILE BOUNDARY VALUE FOR THE WINDSPEED',/
     $' 9  PRINTS OUT A PROBABILITY TABLE FOR THE WIND DIRECTION AND',
     $' SPEED')
CCC
C    *** INPUT THE FIVE BASIC PARAMETERS   ***
CCC
   70 WRITE (ITERM,77)
   77 FORMAT (' INPUT MEAN X,STDEVX,MEAN Y,STDEVY,CORR. COEFF.')
      READ (ITERM,88) XBAR,STDEVX,YBAR,STDEVY,CORR
   88 FORMAT (5F)
      IF (STDEVX.GT.0.AND.STDEVY.GT.0.) GO TO 301
      WRITE (ITERM,300)
  300 FORMAT (' STDEVX AND STDEVY MUST BE GREATER THAN ZERO',/
     $' PLEASE TYPE IN THE BASIC PARAMETERS AGAIN')
      GO TO 70
  301 IF (CORR.GT.-1.AND.CORR.LT.1.) GO TO 303
      WRITE (ITERM,302)
  302 FORMAT (' THE CORRELATION COEFFICIENT MUST BE BETWEEN -1 AND 1.',/
     $' PLEASE TYPE IN THE BASIC PARAMETERS AGAIN.')
      GO TO 70
```

```
CCC
C    ***    CALCULATE RECURRING TERMS SAVED IN COMMON STORAGE    ***
CCC
  303 SQSTY = STDEVY * STDEVY
      SQSTX = STDEVX * STDEVX
      DENOM = 1 - (CORR*CORR)
      PROSTD = STDEVX * STDEVY
CCC
C    ***    ASK USER WHAT OPTION HE WANTS    ***
CCC
    5 WRITE (ITERM,95)
   95 FORMAT('  INPUT DESIRED OPTION')
      READ (ITERM,97) IOPTN
   97 FORMAT (I5)
CCC
C    ***    WARN THE USER IF A NONEXISTENT OPTION IS USED    ***
CCC
      IF (IOPTN.LT.0.OR.IOPTN.GT.9) GO TO 990
CCC
C    ***  GO TO THE SECTION GOVERNING THE APPROPRIATE OPTION ***
CCC
      IF (IOPTN.EQ.0) GO TO 999
      GO TO (10,20,30,40,50,60,70,80,90),IOPTN
CCC
C    ***    THIS SECTIONS CONTROLS OPTION #1    ***
CCC
   10 WRITE (ITERM,110)
  110 FORMAT ('  INPUT PROBABILITY VALUE')
      READ (ITERM,112) PROB
  112 FORMAT (F)
      IF (PROB.LE.0..OR.PROB.GE.1.) GO TO 990
  113 FORMAT (' INPUT NUMBER OF X-YLOW-YHIGH SETS DESIRED')
      WRITE (ITERM,113)
      READ (ITERM,97) NPTS
      WRITE (ITERM,111)
  111 FORMAT (5X,'X',8X,'YLOW',6X,'YHIGH',/3(1X,9('-')))
CCC
C    *** USE "ELIPSE" TO CALCULATE AND WRITE OUT REQUIRED POINT SETS ***
CCC
      CALL ELIPSE (PROB,X,Y,XSMALL,XLARGE,YSMALL,YLARGE,NPTS)
CCC
C    ***    PRINT OUT EXTREME VALUES OF X AND Y    ***
CCC
      WRITE (ITERM,114) XSMALL,XLARGE
      WRITE (ITERM,116) YSMALL,YLARGE
  114 FORMAT (1X,' EXTREME VALUES OF X  ',2(1X,F9.4))
  116 FORMAT (1X,' EXTREME VALUES OF Y  ',2(1X,F9.4))
      GO TO 5
CCC
C    ***    THIS SECTION CONTROLS OPTION #2    ***
CCC
   20 WRITE (ITERM,120)
  120 FORMAT (' INPUT RANGE OF DIRECTIONS')
      READ (ITERM,122) DIR1,DIR2
      IF (DIR1.NE.DIR2) GO TO 21
      WRITE (ITERM,121)
  121 FORMAT (' THE TWO INPUT DIRECTIONS CAN''T BE THE SAME.')
      GO TO 20
   21 DIR1 = TRANS(DIR1)
      DIR2 = TRANS(DIR2)
  122 FORMAT (2F)
      P = PRDIR(DIR1,DIR2)
      IF (P.LT.1.E-04) P = 0.
      WRITE (ITERM,124) P
  124 FORMAT (' PROBABILITY OF GIVEN WIND DIRECTION RANGE',F6.4)
      GO TO 5
CCC
C    ***    THIS SECTION CONTROLS OPTION #3    ***
CCC
   30 WRITE (ITERM,130)
  130 FORMAT (' INPUT RANGE OF SPEEDS ')
      READ (ITERM,132) SPD1,SPD2
  132 FORMAT (2F)
      IF (SPD1.GE.0.AND.SPD2.GE.0.) GO TO 32
      WRITE (ITERM,131)
  131 FORMAT (' ONE OR MORE OF THE INPUT SPEEDS ARE NEGATIVE',/
     $' PLEASE INPUT THE SPEEDS AGAIN.')
      GO TO 30
   32 CALL PRSRD(0.,360.,SPD1,SPD2,PROB)
      IF (PROB.LT.1.E-04) PROB = 0.
      WRITE (ITERM,134) PROB
  134 FORMAT (' PROBABILITY OF GIVEN RANGE OF SPEEDS',F6.4)
      GO TO 5
```

```
CCC
C    ***    THIS SECTION CONTROLS OPTION #4    ***
CCC
   40 WRITE (ITERM,120)
      READ (ITERM,122) DIR1,DIR2
      IF (DIR1.NE.DIR2) GO TO 41
      WRITE (ITERM,121)
      GO TO 40
   41 DIR1 = TRANS(DIR1)
      DIR2 = TRANS(DIR2)
      WRITE (ITERM,130)
      READ (ITERM,132) SPD1,SPD2
      IF (SPD1.GE.0.AND.SPD2.GE.0.) GO TO 42
      WRITE (ITERM,131)
      GO TO 40
   42 IF (DIR2.GE.DIR1) GO TO 49
      CALL PRSRD (DIR1,360.,SPD1,SPD2,PROB1)
      CALL PRSRD (0.,DIR2,SPD1,SPD2,PROB2)
      PROB = PROB1 + PROB2
      GO TO 51
   49 CALL PRSRD (DIR1,DIR2,SPD1,SPD2,PROB)
   51 IF (PROB.LT.1.E-04) PROB = 0.
      WRITE (ITERM,142) PROB
  142 FORMAT (' PROBABILITY OF GIVEN RANGE OF SPEEDS AND DIRECTNS',F7.4)
      GO TO 5
CCC
C    ***    THIS SECTION CONTROLS OPTION #5    ***
CCC
   50 WRITE (ITERM,150)
  150 FORMAT (' INPUT DIRECTION ')
      READ (ITERM,112) DIR
      DIR = TRANS(DIR)
      WRITE (ITERM,130)
      READ (ITERM,132) SPD1,SPD2
      IF (SPD1.GE.0.AND.SPD2.GE.0.) GO TO 52
      WRITE (ITERM,131)
      GO TO 50
   52 CALL RSPGDR(DIR,SPD1,SPD2,PROB)
      WRITE (ITERM,152) PROB
  152 FORMAT (' PROBABILITY OF GIVEN SPEED RANGE AT GIVEN DIRECT.',F6.4)
      GO TO 5
CCC
C    ***    THIS SECTION CONTROLS OPTION #6    ***
CCC
   60 WRITE (ITERM,160)
  160 FORMAT (' INPUT ANGLE OF ROTATION')
      READ (ITERM,112) ALPHA
      CALL ROTATE(ALPHA,STDEVX,STDEVY)
      WRITE (ITERM,162) STDEVX,STDEVY
  162 FORMAT (' NEW STDEVX ',F7.2,' NEW STDEVY ',F7.2)
      WRITE (ITERM,163) XBAR,YBAR,CORR
  163 FORMAT (' NEW MEAN X ',F7.2,' NEW MEAN Y ',F7.2,' NEW CORR ',F6.4)
      GO TO 5
CCC
C    ***    THIS SECTION CONTROLS OPTION #8    ***
CCC
   80 WRITE (ITERM,81)
   81 FORMAT (' INPUT THE REQUIRED PERCENTILE')
   84 READ (ITERM,112) PCNT
      IF (PCNT.GT.0.AND.PCNT.LT.100.) GO TO 86
      WRITE (ITERM,89)
   89 FORMAT (' PERCENTILES MUST BE BETWEEN 0 AND 100.',/
     $' PLEASE INPUT THE NUMBER AGAIN.')
      GO TO 84
   86 PCNT = PCNT / 100.
      CALL SPCNT (PCNT,PSPD)
      WRITE (ITERM,82) PSPD
   82 FORMAT (' CORRESPONDING WIND SPEED  ',F8.4)
      GO TO 5
CCC
C    ***    THIS SECTION CONTROLS OPTION #9    ***
```

```
CCC
   90 WRITE (ITERM,190)
  190 FORMAT (' INPUT THE PERIOD OF RECORD - UP TO 20 CHARACTERS')
      READ (ITERM,191) IPOR
  191 FORMAT (4A5)
   92 WRITE (ITERM,192)
  192 FORMAT (' INPUT THE LEVEL OR LAYER - UP TO 30 CHARACTERS')
      READ (ITERM,193) ILVLYR
  193 FORMAT (6A5)
   94 WRITE (ITERM,194)
  194 FORMAT (' INPUT THE LOCATION - UP TO 25 CHARACTERS')
      READ (ITERM,195) ILOCN
  195 FORMAT (5A5)
   96 WRITE (ITERM,196)
  196 FORMAT (' INPUT THE WIND SPEED UNITS - UP TO 10 CHARACTERS')
      READ (ITERM,197) IWSU
  197 FORMAT (2A5)
      CALL WROSE (IPOR,ILOCN,ILVLYR,IWSU)
      GO TO 5
CCC
C   ***   PROGRAM ABORT FOR A NONEXISTENT OPTION    ***
CCC
  990 WRITE (ITERM,900)
  900 FORMAT (' ILLEGAL OPTION NUMBER GIVEN - PROGRAM STOPPED.')
  999 STOP
      END

CCC
C   ***   FUNCTION A - COMPUTES TERM "A" P.23   ***
CCC
      FUNCTION A(SINDIR,COSDIR,CORR,DENOM,N)
      COMMON /BLK1/ SQSTX,SQSTY,PROSTD
      A = ((COSDIR*COSDIR/SQSTY) - (2*CORR*COSDIR*SINDIR/PROSTD)
     $+ (SINDIR*SINDIR/SQSTX))/DENOM
      IF (N.EQ.2) RETURN
      A = SQRT(A)
      RETURN
      END
CCC
C   ***   FUNCTION B - COMPUTES TERM "B"  P.23  ***
CCC
      FUNCTION B(SINDIR,COSDIR,CORR,DENOM)
      COMMON /BLK1/ SQSTX,SQSTY,PROSTD
      COMMON /BLK2/ XBAR,YBAR
      B = ((YBAR*COSDIR/SQSTY) - (CORR*(YBAR*SINDIR+XBAR*COSDIR)
     $ /PROSTD) + (XBAR*SINDIR/SQSTX))/DENOM
      RETURN
      END
CCC
C   ***   FUNCTION C - COMPUTES TERM "C"  P.23   ***
CCC
      FUNCTION C(CORR,DENOM,N)
      COMMON /BLK1/ SQSTX,SQSTY,PROSTD
      COMMON /BLK2/ XBAR,YBAR
      C = ((YBAR*YBAR/SQSTY) - (2*CORR*XBAR*YBAR/PROSTD)
     $+ (XBAR*XBAR/SQSTX))/DENOM
      IF (N.EQ.2) RETURN
      C = SQRT(C)
      RETURN
      END
CCC
C   ***   FUNCTION D - COMPUTES TERM "D"  P.23  ***
CCC
      FUNCTION D(DENOM)
      COMMON /BLK1/ SQSTX,SQSTY,PROSTD
      DATA TWOPI/6.2831852/
      D = 1/(TWOPI*PROSTD*SQRT(DENOM))
      RETURN
      END

CCC
C   ***   SUBROUTINE ELIPSE - CALCULATES AND PRINTS POINTS ON AN    ***
C   ***   ELLIPTICAL PROBABILITY CONTOUR                            ***
```

```
CCC
      SUBROUTINE ELIPSE(PROB,X,Y,XSMALL,XLARGE,YSMALL,YLARGE,NPTS)
      COMMON /BLK1/ SQSTX,SQSTY,PROSTD
      COMMON /BLK2/ XBAR,YBAR
      COMMON /BLK3/ CORR,DENOM
      REAL LMBD,LMBDE,LYROOT
      Q = ALOG(1. - PROB)
      LMBD = SQRT(-2.*DENOM*Q)
      LMBDE = SQRT(-2.*Q)
      A = SQSTY
      IT = -1
      B = -2.*CORR*PROSTD
      C = SQSTX
      D = -1.*((B*YBAR)+(2.*A*XBAR))
      E = -1.*((B*XBAR)+(2.*C*YBAR))
      F = (A*XBAR*XBAR) + (C*YBAR*YBAR) + (B*XBAR*YBAR)
     $ - (A*C*LMBD*LMBD)
      XFACT = LMBDE * SQRT(SQSTX)
      YFACT = LMBDE * SQRT(SQSTY)
      XSMALL = XBAR - XFACT
      XLARGE = XBAR + XFACT
      YSMALL = YBAR - YFACT
      YLARGE = YBAR + YFACT
      XDIFF = XLARGE - XSMALL
      NPTS = NPTS - 1
      DO 20 N = 1,NPTS+1
      XTEMP = XSMALL + XDIFF*(N-1)/NPTS
      QUADA = C
      QUADB = (B*XTEMP) + E
      QUADC = (A*XTEMP*XTEMP) + (D*XTEMP) + F
      QROOT = (QUADB*QUADB) - (4.*QUADA*QUADC)
      IF (QROOT.LT.0) QROOT = 0.
      QFACT = SQRT(QROOT)
      LYROOT = ((-1.*QUADB) - SQRT(QROOT))/(2.*QUADA)
      UYROOT = ((-1.*QUADB) + SQRT(QROOT))/(2.*QUADA)
  222 FORMAT (3(1X,F9.4))
      WRITE (IT,222) XTEMP,LYROOT,UYROOT
   20 CONTINUE
      RETURN
      END

CCC
C  **  FUNCTION PDIR - GIVES PROBABILITY DENSITY FOR WIND DIRECTION **
CCC
      FUNCTION PDIR(THETA)
      COMMON /BLK1/ SQSTX,SQSTY,PROSTD
      COMMON /BLK2/ XBAR,YBAR
      COMMON /BLK3/ CORR,DENOM
      DATA SQRT2P/2.506628/
      SINDIR = SIN(THETA)
      COSDIR = COS(THETA)
      ASQ = A(SINDIR,COSDIR,CORR,DENOM,2)
      A1 = SQRT(ASQ)
      B1 = B(SINDIR,COSDIR,CORR,DENOM)
      BOVA = B1 / A1
      BOVASQ = BOVA * BOVA
      PDIR = (D(DENOM)/ASQ) * EXP(-.5*C(CORR,DENOM,2)) *
     $(1 + (SQRT2P*BOVA*EXP(.5*BOVASQ)*PNORM(BOVA)))
      RETURN
      END

CCC
C  **  FUNCTION PRDIR - COMPUTES PROBABILITY OF WIND DIRECTION RANGE **
CCC
      FUNCTION PRDIR(DIR1,DIR2)
      DATA CONV/1.745329E-02/,PRDIR,PRDIRO/2*0./,ITERM/-1/
      NSLICE = 20
    5 PRDIR = 0.
      IF (DIR2 - DIR1) 10,30,30
   10 SLSIZE = (360.-DIR1)/NSLICE
      DO 12 IC = 1,NSLICE
      ZDIR = DIR1 + (IC*SLSIZE) - (SLSIZE/2.)
   12 PRDIR = PRDIR + (PDIR(ZDIR*CONV))*SLSIZE*CONV
      SLSIZE = DIR2/NSLICE
      DO 14 IC = 1,NSLICE
      ZDIR = (IC*SLSIZE) - (SLSIZE/2.)
   14 PRDIR = PRDIR + (PDIR(ZDIR*CONV))*SLSIZE*CONV
   16 IF (PRDIR - PRDIRO.LT.1.E-05) RETURN
      NSLICE = NSLICE * 2
      PRDIRO = PRDIR
      GO TO 5
```

```
   30 SLSIZE = (DIR2-DIR1)/NSLICE
      DO 32 IC = 1,NSLICE
      ZDIR = DIR1 + (IC*SLSIZE) - (SLSIZE/2.)
   32 PRDIR = PRDIR + (PDIR(ZDIR*CONV))*SLSIZE*CONV
      GO TO 16
      END

CCC
C  **  SUBROUTINE PRSRD - COMPUTES THE PROBABILITY OF A RANGE OF   **
C  **  SPEEDS AND A RANGE OF DIRECTIONS                            **
CCC
      SUBROUTINE PRSRD(DIR1,DIR2,SPD1,SPD2,PROB)
      DATA CONV/1.745329E-02/
      ITERM = -1
      JSLICE = 20.
    5 PROB = 0.
      IF (DIR2.EQ.DIR1) GO TO 20
      SLSIZE = (DIR2-DIR1)/JSLICE
      DO 10 IN = 1,JSLICE
      ZDIR = DIR1 + (IN*SLSIZE) - (SLSIZE/2.)
      CALL RSPGDR(ZDIR,SPD1,SPD2,PRBINT)
      DD2 = DIR1 + IN*SLSIZE
      DD1 = DIR1 + (IN-1)*SLSIZE
   10 PROB = PROB + PRBINT * PRDIR(DD1,DD2)
      IF (PROB-PROBO.LT.1.E-04) RETURN
      JSLICE = JSLICE * 2
      PROBO = PROB
      GO TO 5
   20 CALL RSPGDR(DIR1,SPD1,SPD2,PRBINT)
      PROB = PRBINT * PRDIR(DIR1,DIR1)
      RETURN
      END

CCC
C  **  SUBROUTINE ROTATE - ROTATES COORDINATES THROUGH A GIVEN ANGLE  **
CCC
      SUBROUTINE ROTATE(ALPHA,STDEVX,STDEVY)
      COMMON /BLK1/ SQSTX,SQSTY,PROSTD
      COMMON /BLK2/ XBAR,YBAR
      COMMON /BLK3/ CORR,DENOM
      DATA CONV/1.745329E-02/
      CVANG = ALPHA * CONV
      COSA = COS(CVANG)
      SINA = SIN(CVANG)
      COSSQA = COSA * COSA
      SINSQA = SINA * SINA
      OLDXBR = XBAR
      OLDSQX = SQSTX
      OLDSQY = SQSTY
      SQSTX =(SQSTX*COSSQA) + (SQSTY*SINSQA) + (2*CORR*PROSTD*COSA*SINA)
      SQSTY =(SQSTY*COSSQA)+(OLDSQX*SINSQA) - (2*CORR*PROSTD*COSA*SINA)
      XBAR = (XBAR*COSA) + (YBAR*SINA)
      YBAR = (YBAR*COSA) - (OLDXBR*SINA)
      COVXY = CORR * PROSTD
      COVXY = COVXY * (COSSQA - SINSQA) + (COSA*SINA*(OLDSQY-OLDSQX))
      STDEVX = SQRT(SQSTX)
      STDEVY = SQRT(SQSTY)
      PROSTD = STDEVX * STDEVY
      CORR = COVXY / PROSTD
      RETURN
      END

CCC
C  **  SUBROUTINE RSPGDR - COMPUTES PROBABILITY OF A RANGE OF  **
C  **          SPEEDS GIVEN A WIND DIRECTION                   **
CCC
      SUBROUTINE RSPGDR(DIR,SPD1,SPD2,PROB)
      IF (SPD1.EQ.0.) GO TO 10
      IF (SPD2.EQ.0.) GO TO 20
      CALL SLEGDR(DIR,SPD1,PROB1)
      CALL SLEGDR(DIR,SPD2,PROB2)
      PROB = PROB2 - PROB1
      IF (SPD2.LT.SPD1) PROB = PROB + 1
      RETURN
   10 CALL SLEGDR(DIR,SPD2,PROB)
   30 RETURN
   20 CALL SLEGDR(DIR,SPD1,PROB)
      PROB = 1. - PROB
      RETURN
      END
```

```
CCC
C  **  SUBROUTINE SLEGDR - COMPUTES THE PROBABILITY OF THE     **
C  **  SPEED BEING LESS THAN OR EQUAL TO A GIVEN SPEED WHEN    **
C  **  THE WIND DIRECTION IS KNOWN                             **
CCC
      SUBROUTINE SLEGDR (DIR,SPD,PROB)
      COMMON /BLK1/ SQSTX,SQSTY,PROSTD
      COMMON /BLK2/ XBAR,YBAR
      COMMON /BLK3/ CORR,DENOM
      DATA CONV/1.745329E-02/,SQRT2P/2.506628/
      THETA = DIR * CONV
      COSTHT = COS(THETA)
      SINTHT = SIN(THETA)
      ASQ = A(SINTHT,COSTHT,CORR,DENOM,2)
      A1 = SQRT(ASQ)
      B1 = B(SINTHT,COSTHT,CORR,DENOM)
      BOVA = B1 / A1
      RS = (A1*SPD) - BOVA
      ZX = .5*RS*RS
      IF (ZX.GT.80.) ZX = 80.
      ZZ = -.5*B1*B1/ASQ
      IF (ZZ.LT.-80.) ZZ = -80.
      PROB = 1 - ((EXP(-ZX) + (SQRT2P*BOVA*(1. - PNORM(RS))))
     $ /(EXP(ZZ) + (SQRT2P*BOVA*PNORM(BOVA))))
   20 RETURN
      END

CCC
C  *  FUNCTION PNORM - GIVES THE NORMAL PROBABILITY DENSITY FUNCTION  *
CCC
      FUNCTION PNORM(X)
      DATA C0/1.1892071/,C1/.23410017/,C2/.13698952/,C3/4.0908724E-4/,
     $C4/2.3221647E-2/
      IF (X.LT.0.) GO TO 1
      A = ((((C4*X+C3) *X +C2) * X + C1) * X + C0
      IF (A.GT.1.E20) A = 1.E20
      PNORM = 1.-1./(A*A*A*A)
      RETURN
    1 A = ((((C4*X-C3) *X +C2) *X - C1) * X + C0
      IF (A.GT.1.E20) A = 1.E20
      PNORM = 1./(A*A*A*A)
      RETURN
      END

CCC
C  **  FUNCTION TRANS - MODIFIES INPUT WIND DIRECTION SO THAT  **
C  **  THE WIND VELOCITY VECTORS ALL START AT THE ORIGIN       **
CCC
      FUNCTION TRANS(DIR)
      IF (DIR.EQ.360.) DIR = 359.9999
      IF (DIR.EQ.180.) DIR = 179.9999
      IF (DIR.GE.180.) GO TO 15
      TRANS = DIR + 180.
      RETURN
   15 TRANS = DIR - 180.
      RETURN
      END

CCC
C  ***  SUBROUTINE SPCNT - COMPUTES PERCENTILE VALUES OF WINDSPEED  ***
CCC
      SUBROUTINE SPCNT(PCNT,PSPD)
      COMMON /BLK2/ XBAR,YBAR
      REAL LOWLIM
      DATA LOWLIM/0./
      ULIM = SQRT(XBAR*XBAR + YBAR*YBAR)/(1.-PCNT)
      IF (PCNT.GT..85) ULIM = ULIM / (-1.*ALOG(1.-PCNT))
      LOWLIM = 0.
    5 HLIM = (ULIM + LOWLIM)/2.
      CALL PRSRD(0.,360.,0.,HLIM,PCNTH)
      IF (ABS(PCNTH-PCNT).LT.1.E-04) GO TO 30
      IF (PCNTH - PCNT) 10,30,20
   10 LOWLIM = HLIM
      GO TO 5
   20 ULIM = HLIM
      GO TO 5
   30 PSPD = HLIM
      RETURN
      END
```

```
CCC
C  **  SUBROUTINE WROSE - GIVES A TABLE OF PROBABILITIES  **
C  **   OF VARIOUS RANGES OF WIND DIRECTIONS AND SPEEDS   **
CCC
      SUBROUTINE WROSE(IPOR,ILOCN,ILVLYR,IWSU)
      DIMENSION ILOCN(5),ILVLYR(6),IPOR(4),RDIR(16),RSPD(11),PROB(12),
     $IWSU(2),NMEDIR(18),SPDTOT(12)
      DATA ITERM,IY,IFORM/-1,'Y   ',"060000000000/
      DATA RDIR/11.25,33.75,56.25,78.75,101.25,123.75,146.25,168.75,
     $191.25,213.75,236.25,258.75,281.25,303.75,326.25,348.75/
      DATA RSPD/1.,10.,20.,30.,40.,50.,60.,75.,100.,150.,200./
      DATA NMEDIR/'   S ','  SSW','   SW','  WSW','   W ','  WNW',
     $'   NW','  NNW','   N ','  NNE','   NE','  ENE','   E ','  ESE',
     $'   SE','  SSE',' CALM',' TOTL'/
      WRITE (ITERM,20)
   20 FORMAT (' DO YOU WANT THE PROBABILITY TABLE WRITTEN OUT TO',
     $' A FILE? (Y=YES,N=NO)')
      READ (ITERM,25) IR
   25 FORMAT (A5)
      IF (IR.NE.IY) GO TO 30
      WRITE (ITERM,35)
   35 FORMAT (' PLEASE INPUT A FILENAME - UP TO 5 CHARACTERS')
      READ (ITERM,25) IFILE
      WRITE (ITERM,26)
   26 FORMAT (' WOULD YOU LIKE THE PROGRAM TO STOP AFTERWARDS?')
      READ (ITERM,25) IR
      IF (IR.EQ.IY) ISTOP = 1
      WRITE (ITERM,27) IFILE
   27 FORMAT (' YOUR PROBABILITY TABLE WILL BE SENT OUT TO',
     $' FILE ',A5,'.DAT')
      OPEN (UNIT=20,FILE=IFILE)
      ITERM = 20
   30 WRITE (ITERM,50) IFORM,ILOCN,ILVLYR,IPOR,IWSU
   50 FORMAT (A1,/4X,5A5,1X,6A5,4A5//,2X,'WIND SPEED - ',2A5/,2X,
     $'DIR  -----'/,2X,'---'/,9X,'1-10 10-20 20-30 30-40 40-50 50-60
     $ 60-75 75-100 100-150 150-200 >200 TOTAL')
      DIRTOT = 0.
      DO 100 IS = 1,10
      SPDLOW = RSPD(IS)
      SPDHI = RSPD(IS+1)
      CALL PRSRD(348.75,360.,SPDLOW,SPDHI,PROB1)
      CALL PRSRD(0.,11.25,SPDLOW,SPDHI,PROB2)
      PROB(IS) = PROB1 + PROB2
      DIRTOT = DIRTOT + PROB(IS)
  100 SPDTOT(IS) = PROB(IS)
      CALL PRSRD(348.75,360.,200.,0.,PROB1)
      CALL PRSRD(0.,11.25,200.,0.,PROB2)
      PROB(11) = PROB1 + PROB2
      PROB(12) = PROB(11) + DIRTOT
      SPDTOT(12) = PROB(12)
      DO 125 I = 1,12
  125 IF (PROB(I).LT.1.E-04)  PROB(I) = 0.
      WRITE (ITERM,700) NMEDIR(1),PROB
  700 FORMAT (1X,A5,2X,6(F5.4,1X),3(F5.4,2X),2(F5.4,1X),F6.4/)
      DO 200 ID = 1,15
      DIRTOT = 0.
      DO 150 IS = 1,10
      SPDLOW = RSPD(IS)
      SPDHI = RSPD(IS+1)
      DIRLOW = RDIR(ID)
      DIRHI = RDIR(ID+1)
      CALL PRSRD(DIRLOW,DIRHI,SPDLOW,SPDHI,PROB(IS))
      DIRTOT = DIRTOT + PROB(IS)
  150 SPDTOT(IS) = SPDTOT(IS) + PROB(IS)
      CALL PRSRD(DIRLOW,DIRHI,200.,0.,PROB(11))
      PROB(12) = PROB(11) + DIRTOT
      SPDTOT(12) = SPDTOT(12) + PROB(12)
      DO 175 I = 1,12
  175 IF (PROB(I).LT.1.E-04) PROB(I) = 0.
  200 WRITE (ITERM,700) NMEDIR(ID+1),PROB
      CALL PRSRD(0.,360.,0.,1.,PCALM)
      IF (PCALM.LT.1.E-04) PCALM = 0.
      WRITE (ITERM,710) NMEDIR(17),PCALM
  710 FORMAT (1X,A5,2X,F5.4/)
      SPDTOT(1) = SPDTOT(1) + PCALM
      SPDTOT(12) = SPDTOT(12) + PCALM
      WRITE(ITERM,700) NMEDIR(18),SPDTOT
      IF (ITERM.NE.-1) CLOSE(UNIT = 20)
      ITERM = -1
      IF (ISTOP.EQ.1) STOP
      WRITE (ITERM,250)
  250 FORMAT (' ***  YOUR PROBABILITY TABLE IS READY  ***')
      RETURN
      END
```


ATE
ME